

# *Anopheles (Anopheles) forattinii*: a New Species in Series Arribalzagia (Diptera: Culicidae)

RICHARD C. WILKERSON<sup>1</sup> AND MARIA ANICE MUREB SALLUM<sup>1, 2</sup>

Department of Entomology, Walter Reed Army Institute of Research, Washington, DC 20307-5100

J. Med. Entomol. 36(3): 345-354 (1999)

**ABSTRACT** *Anopheles (Anopheles) forattinii* new species, a member of the Series Arribalzagia, is described with illustrations of the larval and pupal stages, and male and female genitalia. It is contrasted with 2 similar species, *An. (Anopheles) costai* Fonseca & Ramos and *An. (Anopheles) mediopunctatus* (Lutz). This species, and *An. costai*, occur over much of South America where both have been misidentified as *An. mediopunctatus*, a species presently only known from southeastern Brazil.

**KEY WORDS** *Anopheles, forattinii*, new species, Arribalzagia, description, taxonomy

THERE ARE NOW 3 species that were formerly identified as *Anopheles (Anopheles) mediopunctatus* (Lutz) from South America. Two of these, *An. mediopunctatus* and *An. costai* Fonseca & Ramos, are treated by Sallum et al. (Sallum et al. 1999). The 3rd species, *An. forattinii* n. sp., is described here. Because the adult females of these 3 species are indistinguishable, it is not possible to identify which have been reported in the literature. However, *An. mediopunctatus* s.s. has been verified by us only from the coastal regions of the States of São Paulo, Rio de Janeiro, and Paraná, Brazil, whereas the other 2 species are sympatric over a large area of South America. *An. mediopunctatus* s.l. is commonly reported in lowland tropical South America (Deane et al. 1948; Forattini 1962; Lourenço et al. 1989; Tadei et al. 1983, 1988). It is primarily a forest species, often associated with simian malaria (R. Lourenço, personal communication), and in the laboratory is quite susceptible to human malaria (Klein et al. 1991a, b). This taxon is a member of the Series Arribalzagia as defined by Reid and Knight (1961) and Wilkerson and Peyton (1990).

## Materials and Methods

We followed Harbach and Knight (1980, 1982) for terminology of morphological characters and Wilkerson and Peyton (1990) for wing spot characters. Abbreviations used are as follows: G, genitalia; L, larva; Le, larval exuviae; P, pupa; Pe, pupal exuviae. Collection codes and numbers for most recent collections consist of a country code in capital letters followed by

a collection number and an individual specimen number (e.g., BR 279-1 is an individual from collection 279 from Brazil). Specimen numbers 1-99 are used if there are associated larval and pupal exuviae, numbers 100 and up are used if there is only a pupal exuviae. Progeny from a single female are indicated by a number in parentheses [e.g., BR 279(12)-1 is an individual from female number 12].

**Taxonomic Treatment.** *Anopheles (Anopheles) forattinii* n. sp. Female (Fig. 1G). Integument light to dark brown with grayish pollinosity, more evident on the vertex. **Head.** Interocular space with 10-16 ( $n = 9$  for this and following measurements and counts except where indicated) long, whitish setae and row of small, narrow, appressed white to light cream scales; vertex, occiput and upper portion of postgena with several erect, truncate scales; patch of grayish white scales on anterodorsal area of vertex nearly concolorous with pale scales on median area of anterior promontory, patch of black scales laterally and posteriorly on head concolorous with scales on anterior scutal fossa and upper anteprepronotum; head with 4-6 long, dark ocular setae; postgena with long black setae ventrally. Clypeus bare. Pedicel of antenna with several small, dorsolateral, narrow to broad, grayish white spatulate scales; flagellomere 1 with several narrow to broad dark brown scales and a few white scales on ventral surface, and a few white scales on dorsal surface. Scales of maxillary palpus slender, spatulate, mostly dark brown with intermixed dark brown setae; scales on palpomere 2-4 erect, palpomere 2 mostly dark-scaled, with a few pale yellow scales on 0.5 basal of inner side of dorsal surface; palpomere 3 and 4 mostly dark-scaled with small patch of pale yellow scales basally and a few intermixed pale yellow scales; palpomere 5 dark-scaled with pale yellow scales on base and apex, sometimes with pale yellow scales on middle of outer side of palpomere; length of maxillary palpus 2.11-2.35 mm (mean = 2.24 mm), ratio of

<sup>1</sup> To whom correspondence should be addressed: Walter Reed Biosystematics Unit, Museum Support Center, MRC 534, Smithsonian Institution, Washington, DC 20560.

<sup>2</sup> Núcleo de Pesquisa Taxonômica e Sistemática em Entomologia Médica (NUPTM), Departamento de Epidemiologia, Faculdade de Saúde Pública, Universidade de São Paulo, Av. Arnaldo, 715, CEP 01246-904, São Paulo, Brasil.

Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>1999</b>		2. REPORT TYPE		3. DATES COVERED <b>00-00-1999 to 00-00-1999</b>	
4. TITLE AND SUBTITLE <b>Anopheles (Anopheles) forattinii: a New Species in Series Arribalzagia (Diptera: Culicidae)</b>				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>Walter Reed Army Institute of Research, Department of Entomology, Washington, DC, 20307</b>				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT <b>see report</b>					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>10</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

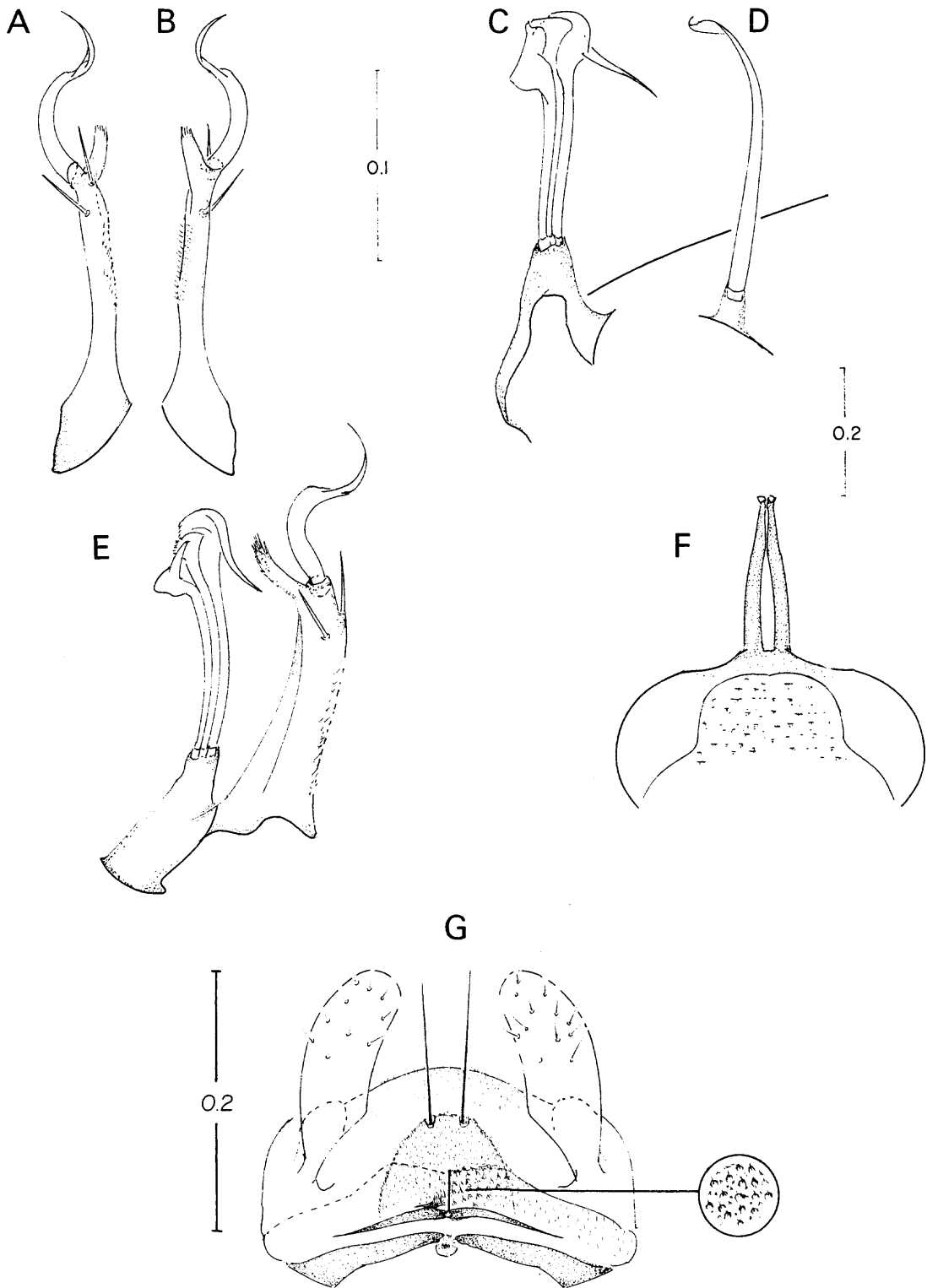


Fig. 1. *An. forattinii* n. sp. male genitalia (A-F). (A) Ventral lobe of claspette lateral aspect. (B) Ventral lobe of claspette mesal aspect. (C) Dorsal lobe of claspette. (D) Parabasal seta 1. (E) Claspette lateral aspect. (F) Tergum IX ventral aspect. (G) *An. forattinii* female genitalia ventral aspect. Scale in millimeters.

length of palpomeres 2–5 to total length of palpus, 2 = 0.30–0.33 (mean = 0.31), 3 = 0.34–0.38 (mean = 0.36), 4 = 0.20–0.22 (mean = 0.21), 5 = 0.12–0.13 (mean = 0.12); ratio of palpomere 4–5, 1.60–1.86 (mean = 1.74); palpus 1.02–1.11 (mean = 1.08) forefemur length. Proboscis dark-scaled, base with long erect scales and setae; proboscis length 2.10–2.51 mm (mean = 2.30 mm), proboscis 0.98–1.11 (mean = 1.03) palpus length. *Thorax*. Scutum with 2 prominent dark spots on dorsocentral area just posterior to the ends of prescutal sutures, another in prescutellar area continuing onto scutellum and 2 small spots at end of lateral portions of prescutellar area. Scutal setae numerous, pale yellow with golden reflections, scutum mottled with brown spots, mostly corresponding to setal insertions in acrostichal and dorsocentral areas, anterior promontory with patch of short, broad white scales, sometimes intermixed with a few scales centrally or these scales totally dark. Scutal fossa with sparse white scales on lateral and posterior areas, inner side of anterior scutal fossa with patch of broad, spatulate, dark brown erect scales with a few pale yellow scales intermixed; antealar area with sparse narrow to broad white spatulate scales; supraalar area with white scales, these narrow falcate anteriorly and broad spatulate posteriorly. Scutellum with 12–21 shorter and 10–19 long setae, short setae pale yellow, long setae brown with reddish and golden reflections. Anteprenotum with 10–14 ( $n = 5$ ) yellowish to dark brown setae and several (not counted) upper, dark spatulate scales intermixed with a few pale scales, and patch of pale spatulate scales on lower anteprenotum. Pleural vestiture as follows: all scales white spatulate; upper proepisternum with 3–5 setae, 1,2 scales, scales sometimes absent; prespiracular area with 2–5 setae, 1,2 scales, scales often absent; prealar area with 10–13 ( $n = 6$ ) setae; upper mesokatepisternum with 4–7 ( $n = 8$ ) setae, 7–9 ( $n = 6$ ) scales; lower mesokatepisternum with 3–6 setae, 7–17 scales; upper mesepimeron with 5–10 setae, 5–9 scales. *Legs*. Forecoxa with upper patch of white scales on anterior surface, dark scales below and patch of long, erect white scales posterolaterally; foretrochanter mostly with small appressed white scales and dense patch of dark scales posteriorly, mid- and hindcoxae and trochanters with patches of white scales. Extent and number of pale spots on femur and tibia variable. Base and apex of forefemur pale; midfemur with ventral stripe of pale yellow scales with well-demarcated borders, extending almost entire length of femur; hindfemur with ventral stripe of white scales with less well-demarcated borders than those of midfemur, remainder of hindfemur dark-scaled with spots of pale scales, scales on apex of hindfemur slightly erect; foretibia mostly yellow-scaled, anterior surface with dark spots extending to ventral and dorsal surfaces, midtibia with ventral longitudinal stripe of yellow scales extending to  $\approx 0.7$  from base, anterior, posterior and dorsal surfaces with spots of dark scales, sometimes encircling the tibia, hindtibia speckled yellow and dark; foretarsomeres 1–3 mostly yellow-scaled with spots of dark scales on anterior and dorsal surfaces, sometimes en-

Table 1. *An. forattinii*: descriptive statistics for ratios of costal wing spot lengths to length of wing measured from the humeral crossvein ( $n = 15$  wings from 15 individuals)

Wing spot	Range	Mean	SD
Basal pale	0.06–0.11	0.09	0.02
Prehumeral dark	0.29–0.46	0.41	0.05
Humeral pale	0.04–0.11	0.07	0.02
Humeral dark	0.23–0.41	0.33	0.04
Presector pale	0.03–0.09	0.05	0.02
Presector dark	0.30–0.52	0.42	0.08
Sector pale	0.24–0.42	0.34	0.05
Accessory sector dark	0.12–0.37	0.25	0.06
Sector dark	0.46–0.76	0.65	0.08
Subcostal area	0.66–0.88	0.79	0.08
Presubcostal dark	0.10–0.26	0.19	0.04
Presubcostal pale (proximal)	0.05–0.09	0.07	0.01
Presubcostal pale (distal)	0.04–0.10	0.06	0.02
Postsubcostal dark	0.13–0.31	0.23	0.06
Postsubcostal pale (proximal)	0.03–0.09	0.06	0.01
Postsubcostal pale (distal)	0.03–0.12	0.07	0.02
Subcostal dark	0.06–0.15	0.11	0.03
Preapical dark	0.53–0.83	0.71	0.08
Preapical pale	0.25–0.37	0.32	0.04
Accessory preapical dark	0.13–0.23	0.18	0.03
Apical dark	0.05–0.15	0.09	0.02

circling the tarsomeres, foretarsomeres 4 and 5 yellow-scaled; midtarsomeres 1–4 mostly dark-scaled with spots of yellow scales, midtarsomere 5 yellow-scaled, hindtarsomeres 1–3 yellow-scaled with spots of dark scales, sometimes encircling the segment, hindtarsomere 4 yellow-scaled with ring of dark scales encircling middle of segment, hindtarsomere 5 entirely yellow-scaled. Forefemur length 1.91–2.28 mm (mean = 2.08 mm), ratio of forefemur length to proboscis length 0.86–0.93 (mean = 0.90). *Wing* (Table 1). Length (measured from humeral crossvein to tip of wing, not including fringe) 3.12–4.17 mm (mean = 3.69 mm). Dark scales brown to black, pale wing scales white and pale yellow. Basal pale spot of vein C always present; prehumeral pale spot absent; subcosta basal to humeral crossvein with patch of dark scales, ventrally with dense patch of broad dark scales near humeral crossvein; humeral crossvein dark-scaled dorsally and ventrally, accessory sector dark spot present on C, Sc, and R; always 2 pre- and 2 postsubcostal pale spots and 1 pre- and 1 postsubcostal dark spots; apical dark spot always present. Posterior veins with intermixed pale yellow, white, and dark scales, vein  $R_{4+5}$  with 1,2 white scales followed by a patch of dark scales at proximal end of vein, remainder of vein intermixed with pale and dark scales, vein M mostly dark-scaled or with alternating spots of dark and pale scales, proximal ends of veins  $M_1$  and  $M_2$  dark-scaled,  $M_{3+4}$  pale-scaled with 3 small spots of dark scales, 1 on proximal region and 2 on distal region of vein, mcu with alternating 2 pale and 2 dark spots, CuA with pale yellow scales intermixed with dark scales and 2 patches of dark scales near proximal end of vein, 1A with alternating dark and white spots. Pale fringe spots indistinct. *Halter*. Scabellum, pedicel and capitellum with pale brown integument, dorsal surface of pedicel with white scales, dorsal surface of capitellum with white scales, proximal part of concave center of capitellum

without scales, ventral surface of capitellum dark-scaled. *Abdomen*. Integument brown to dark brown with some grayish pollinosity. Terga with numerous long yellowish setae; terga II-VII with erect, posterolateral dark scales, most often intermixed with white to pale yellow scales; tergum VIII with long, yellowish setae and several dark, spatulate scales intermixed with pale yellow scales on posterior portion of segment. Sterna with scattered brown to yellowish setae; sternum I with patch of white spatulate scales; sterna II-VII with scattered broad, white, spatulate scales and posteromedial patches of erect, spatulate dark scales; sternum VIII with narrow, spatulate, pale yellow scales. *Genitalia* (Fig. 1G). Tergum IX narrow, with small fingerlike lobe on each side of median straight line; cerci elongate, somewhat elliptical in outline with dark scales; postgenital lobe weakly sclerotized, somewhat pentagonal in outline, with small posterior bridge with patch of minute spicules, caudal margin rounded with 2 strong setae at apex; 25-31 weak insular setae; upper and lower vaginal lips indistinct; upper vaginal sclerite well sclerotized.

**Male** (Fig. 1 A-F). As in female except for the following sexual differences. Maxillary palpus  $\approx 1.02$  length of proboscis ( $n = 3$  for this and following measurements except where indicated), apex of palpomere 3, and all palpomere 4 and 5 enlarged. Maxillary palpus with dark brown and pale yellow scales; base of palpomere 2 with erect scales, basal 0.5 with patch of pale yellow scales, a few pale yellow scales at apex of dorsal surface; palpomere 3 with patch of pale yellow scales at base and apex and on apical 0.5 of dorsal surface; palpomere 4 mostly pale yellow, sometimes with longitudinal line of dark scales on ventral surface, a few dark scales at apex, base and in vicinity of middle of palpomere; palpomere 5 usually totally pale yellow, sometimes with a few dark scales on ventral and lateral surfaces. Proboscis length  $\approx 2.89$  mm, with small, decumbent, dark brown scales and ventrobasal patch of erect, long, dark scales; labella dark brown. Foreungues with curved submedian tooth and blunt, external basal tooth. Ninth tergal lobe (Fig. 1F) prominent, slightly curved dorsally, nearly parallel-sided, closely approximated medially, interlobar area very small, straight. Dorsal surface of gonocoxite with a few scattered shorter and moderately long setae, except seta on apicolateral aspect longer; lateral surface with several slender, fusiform and spatulate scales; ventral surface with short to moderately long setae, and 3,4 long setae on apical 0.2 and a few scales proximally; most mesal parabasal spine (parabasal 1) stouter, rodlike with wide sinuous, hooked tip, borne on strong tubercle, parabasal 2 longer, more slender than 1, straight at apex, parabasal 1  $\approx 0.30$  from base of gonocoxite, 6-10 short setae in vicinity of parabasal 1 on medial side of gonocoxite; parabasal 2  $\approx 0.29$  from base of gonocoxite, internal seta stout with slender, curved tip, longer than parabasal 1, base 0.44 distance from base of gonocoxite. *Claspette*. Dorsal lobe of claspette (Fig. 1C) short, somewhat triangular in outline, with 3 strongly modified setae at apex of ventral border, these 3 setae rodlike on about basal 0.6,

curved ventrally but variable shaped at apex, 1 of these setae swollen on apical 0.4, tapering abruptly to an elongate, slender beak directed upward, sometimes ending in short beak; the other seta strong, rodlike, enlarged on apical 0.3, dorsal side of enlarged portion rugose, apex smooth, truncate; the 3rd seta rodlike, greatly enlarged on apical 0.3, dorsal side of enlarged portion rugose, apex rounded, less rugose, with slender, hooklike, elongate beak on ventral side, direct downward; ventral lobe of claspette columnar, elongate, with small spicules scattered along dorsomesal side and strong, sinuous, hooklike seta at apex, 2 smaller slender setae below, 1 of these setae subapical in position, inserted on ventromesal side, the other more basally inserted on ventrolateral surface, and with well developed, elongate, dorsal, upward projection with slender, fingerlike projections at apex, area between dorsal and ventral lobes narrow, somewhat V-shaped. Gonostylus with 6-9 min setae on dorsal side; gonostylar claw short, spiniform and blunt. Aedeagus with 1 pair of large leaflets and an extra pair of minute leaflets, sometimes this extra pair absent or present on one side, 1st pair of leaflets long, narrow, well sclerotized, with minute spicules on inner margin, remaining leaflet smooth.

**Pupa** (Fig. 2). Position and development of setae as figured; range and modal number of branches in Table 2. Integument weakly pigmented, with variably pigmented pattern of dark areas and bars on wing case, slightly darker on leg cases, antennal case with dark pigmentation at flagellomere joints; mesothoracic wings with 2 well developed ridges of unequal size, dorsal ridge larger than ventral ridge, these 2 ridges and area near them light to dark brown; metathoracic wings with sublateral dark areas and associated small ridge; abdominal segments weakly to moderately pigmented, usually dark laterally near seta 9-III-V, segment VIII dark laterally from near base to apex; paddle weakly pigmented, external buttress, base of midrib and base of paddle usually darker than rest of paddle. *Cephalothorax*. Trumpet laticorn, tragus well developed, elongate, fingerlike; secondary cleft present (not measured). *Abdomen*. Tergum I with posterolateral protuberance with distinct denticles (not shown); terga II-VIII with a few small spicules medially; sterna II-VIII with several small spicules medially from near base to apex of each segment; posterior margin of terga II-VII with distinct denticles between seta 6, terga III-VI with protuberance with small denticles just posterior to seta 6, protuberance more developed on segments V and VI; posterior margin of sterna VI, VII with small denticles on middle region; lateral margins of segments II-VIII with several distinct denticles just cephalad of seta 9 base, denticles most obvious on posterior segments. Seta 8-II absent, 9-II-VIII peglike to long and pointed, 9-II minute, weakly pigmented, 9-III-VIII stout, dark, 9-III  $\approx 1.24$  length of 9-II, 9-IV  $\approx 1.62$  length of 9-III, 9-V  $\approx 1.13$  length of 9-IV, 9-VI  $\approx 1.34$  length of 9-V, 9-VII  $\approx 1.16$  length of 9-VI, 9-VIII smooth,  $\approx 1.18$  length of 9-VII, 9-II, III  $\approx 0.10$  length of segment, 9-IV-V  $\approx 0.12$  length of segment, 9-VI-VIII  $\approx 0.15$  length of segment, 10-I, II, 11-II absent, 1-XI

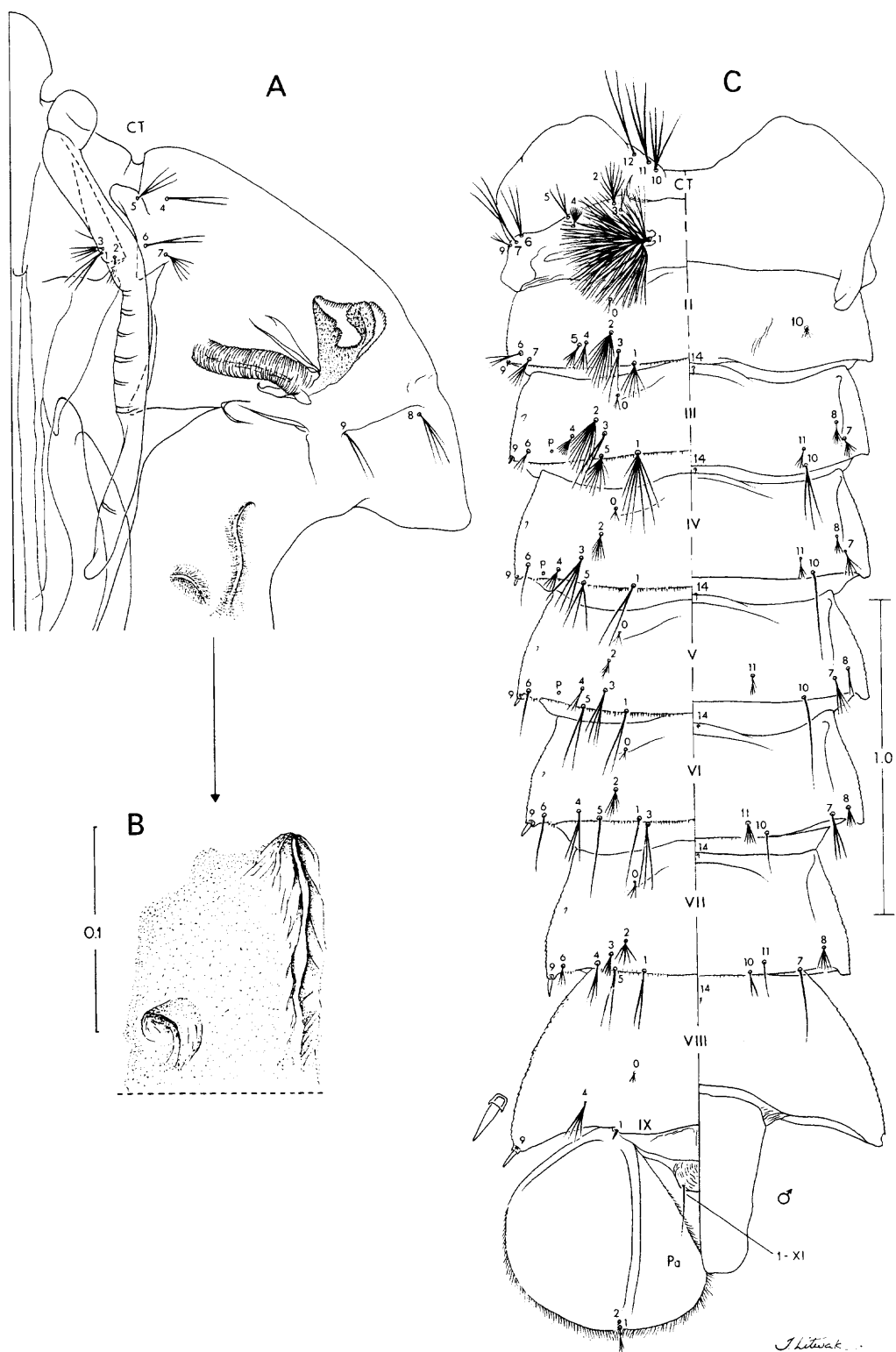


Fig. 2. *An. forattinii* n. sp. pupa. (A) Cephalothorax. (B) Detail of wingcase lateral projections. (C) Metathorax and abdomen, left side dorsal, right side ventral.

Table 2. Number of branches for setae of the pupa of *An. forattinii*: range, mode ( ) based on counts made on 21–30 setae

Seta no.	Cephalotorax CT	Abdominal segments										Paddle P
		I	II	III	IV	V	VI	VII	VIII	IX	XI	
0	—	—	1–4 (2)	2–5 (3)	2–4 (3)	2–4 (2)	2–4 (3)	2–6 (3)	2–5 (3)	—	—	—
1	2–4 (3)	5–14 (11)	2–11 (3)	2–11 (6)	2–6 (3)	1–3 (2)	1–3 (1)	1–3 (1)	—	1	1, 2 (1)	1–5 (3)
2	2–5 (3)	2–8 (6)	7–16 (10)	6–13 (11)	4–10 (6)	3–8 (4)	2–9 (6)	1–8 (4)	—	—	—	1–3 (1)
3	2–4 (3)	1–7 (2)	2–6 (3)	1–4 (2)	3–7 (5)	2–6 (3)	2–6 (3)	2–6 (4)	—	—	—	—
4	2–5 (2)	4–11 (8)	3–7 (5)	4–9 (7)	5–8 (6)	3–6 (4)	2–4 (3)	2–4 (3)	3–6 (4)	—	—	—
5	2–5 (3)	2–6 (4)	3–8 (5)	4–17 (9)	2–4 (3)	1–4 (2)	1–3 (2)	1–3 (2)	—	—	—	—
6	2–4 (3)	2–5 (3)	2–4 (2)	1–3 (2)	1	1	1	1–4 (2)	—	—	—	—
7	2–6 (4)	3–8 (4)	3–5 (4)	3–7 (6)	4–8 (6)	2–6 (3)	2–4 (3)	1–3 (1)	—	—	—	—
8	2–7 (4)	—	—	3–7 (5)	2–6 (3)	2–4 (3)	2–5 (3)	4–7 (6)	—	—	—	—
9	2–3 (2)	1–3 (2)	1	1	1	1	1	1	1	—	—	—
10	3–11 (5)	—	—	2–4 (3)	1–3 (1)	1–3 (1)	1, 2 (1)	1, 2 (1)	—	—	—	—
11	2–5 (3)	—	—	1–4 (3)	1–4 (3)	1–4 (3)	2–7 (3)	1, 2 (1)	—	—	—	—
12	1, 2 (2)	—	—	—	—	—	—	—	—	—	—	—
13	—	—	—	—	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1, 2 (1)	—	1–3 (1)	1–4 (2)	—	—	—

present, single or double. Segment VII 1.04–1.26 (mean = 1.15) length of segment VI; segment VIII 1.32–1.60 (mean = 1.47) length of segment VI. Width/length (width at posterior margin) of segment VI 2.62–3.13 (mean = 2.96), VII 2.22–2.58 (mean = 2.43), VIII 2.03–2.32 (mean = 2.20). Paddle length 0.69–0.83 mm (mean = 0.76 mm), width 0.45–0.61 mm (mean = 0.55 mm), length/width ratio 1.24–1.57 (mean = 1.39), somewhat rounded in outline; refractile index 0.66–0.75 (mean = 0.70); length of marginal spicules 0.02–0.07 mm (mean = 0.04 mm).

**Larva (Fig. 3).** Position and development of setae as figured; range and modal number of branches in Table 3. **Head.** Antennal length 0.30–0.35 mm (mean = 0.33 mm), tapered toward apex, 5.88–6.25 (mean = 6.0) longer than wide, with spicules longer and more numerous in vicinity of seta 1-A; ventral surface with sparse, short spicules; seta 1-A with 12–23 branches, inserted 0.31–0.38 (mean = 0.35) of distance from base of antenna; seta 2-A pointed; 3-A truncate, fringed at apex (not illustrated); 4-A plumose on about apical 0.8, shorter than 2-A or 3-A. Seta 2-C single to 2- to 7-branched on apical 0.3, 1.0–1.25 (mean = 1.08) length 3-C, seta 2-C close to mate of opposite side, distance between bases 1.5–2.0 (mean = 1.75) width base of single seta; 3-C ≈ 0.80–1.0 length of 2-C, with 5–10 branches, clypeal index (distance between bases 2-C and 3-C on 1 side/distance between bases of 2-C) 2.50–3.67 (mean = 3.07). **Thorax.** Seta 1-P not palmate, always single; 9, 10, 12-P single, 11-P single or double; 9–12-M single, 12-M ≈ 0.3 length of 9, 10-M, 11-M very short; 3-T weakly developed, hyaline, palmate; 11-T very short, ≈ 0.25 length of 12-T, 12-T moderately developed. **Abdomen.** Integument hyaline, with minute spicules on ventral surface, more evident on central portion of each segment; setae 1-I–VII palmate, 1-I, II weakly developed, hyaline (not illustrated), leaflets of developed setae broad with jagged margins, apices weakly pigmented. Seta 1-X not inserted on saddle. Saddle with minute, sparse spicules on lateral surface. Integument of posterior margin of segment X with several, strongly developed, dark spicules. **Spiracular apparatus.** Pecten with 15–19 teeth; arrangement of teeth alternating long and short, with

4–6 long and 9–13 short; long spines 2.93–4.47 (mean = 4.07) length of short spines.

**Type Data. HOLOTYPE.** Male with associated slide mounted larval and pupal exuviae and slide mounted male genitalia, from the progeny brood of a female captured on human bait, data as follows: Brazil, Rondonia, Costa Marques, USAMRU-B laboratory, 21-V-1990, collection and specimen no. BR 289(12)-1. Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

**PARATYPES.** A total of 400 specimens consisting of 43 females, 92 males, 110 pupal exuviae, 109 larval exuviae, 44 male genitalia, and 2 female genitalia from Brazil, State of Rondonia, Costa Marques as follows: 1-VI-1988, BR 001–2 ♂ PeLe, -3 ♂ PeLe ♂G, -4 ♀ PeLe, -7 ♂ PeLe ♂G, -8 ♂ PeLe ♂G, -10 ♀ PeLe, -11 ♂ PeLe ♂G, -12 ♀ PeLe, -15 ♀ PeLe, -16 ♀ PeLe, -17 ♂ PeLe ♂G, -18 ♀ PeLe, -19 ♂ PeLe ♂G, -20 ♂ PeLe ♂G; 27-V-1991, BR 002–1 ♂ ♂G, -4 ♂ ♂G, -8, ♂ ♂G, -14 ♂ ♂G; 24-V-1989, BR 133(1)-1 ♂ ♂G, -2 ♂ ♂G, -3 ♀; 23–28-IV-1990, BR 277(2)-1 ♂ PeLe; BR 277(3)-1 ♂ PeLe ♂G, -5 ♂ PeLe ♂G; BR 277(4)-1 ♂ PeLe ♂G; BR 277(5)-1 ♀, -2 ♀ PeLe; BR 277(7)-1 ♂ PeLe ♂G; BR 277(8)-1 ♂ PeLe ♂G; BR 277(9)-1 ♂ PeLe ♂G; BR 277(11)-1 ♂ PeLe, -2 ♂ PeLe ♂G; BR 277(12)-1 ♂ PeLe ♂G, -2 ♂ PeLe ♂G, -3 ♀ Pe; BR 277(15)-1 PeLe; BR 279(1)-1 ♂ ♂G, -2 ♂ ♂G, -3 ♂, -4 ♂, -5 ♂, -6 ♀, -7 ♂, -8 ♂; BR 279(2)-1 ♂ ♂G, -2 ♂ ♂G, -3 ♂; 21–28-V-1990, BR 289(10)-1 ♂ PeLe, -2 ♂ PeLe, -3 ♀ PeLe, -4 ♂ PeLe ♂G, -5 ♂ PeLe ♂G, -8 ♀ PeLe; BR 289(11)-1 ♂ PeLe ♂G, -2 ♂ PeLe ♂G, -3 ♂ PeLe, -4 ♀ PeLe, -5 ♂ PeLe, -6 ♂ PeLe; BR 289(12)-2 ♂ PeLe ♂G, -3 ♂ PeLe, -4 ♂ PeLe, -5 ♂ PeLe, -6 ♀ PeLe, -7 ♂ PeLe, -8 ♀ PeLe, -9 ♀ PeLe, -10 ♂ PeLe, -11 ♀ PeLe ♀G, -12 ♂ PeLe, -13 ♂ PeLe, -14 ♂ PeLe, -15 ♂ PeLe, -16 PeLe, -17 ♀ PeLe, -18 ♀ PeLe, -19 ♀ PeLe; BR 289(13)-1 ♂ PeLe ♂G, -2 ♂ PeLe ♂G, -3 ♂ PeLe, -4 ♂ PeLe, -5 ♂ PeLe, -6 ♂ PeLe, -7 ♂ PeLe, -8 ♂ PeLe; BR 291(2)-1 ♂ PeLe ♂G, -2 ♂ PeLe ♂G, -3 ♂ PeLe, -4 ♀ PeLe, -5 ♀ PeLe ♀G; 19–V-1990, BR 320(2)-1 ♂G, -6 ♂G; 5–11-VII-1991, BR 420(1)-1 ♂ PeLe ♂G, -2 ♀, -3 ♂ PeLe ♂G, -4 ♂ PeLe, -5 ♀, -6 ♂ PeLe, -7 ♀ PeLe, -8 ♀ PeLe, -9 ♂ PeLe, -10 ♀ PeLe, -11 ♀, -12 ♀ PeLe, -13 ♀ PeLe, -14 ♂ PeLe, -15 ♀; BR 420(2)-1 ♂

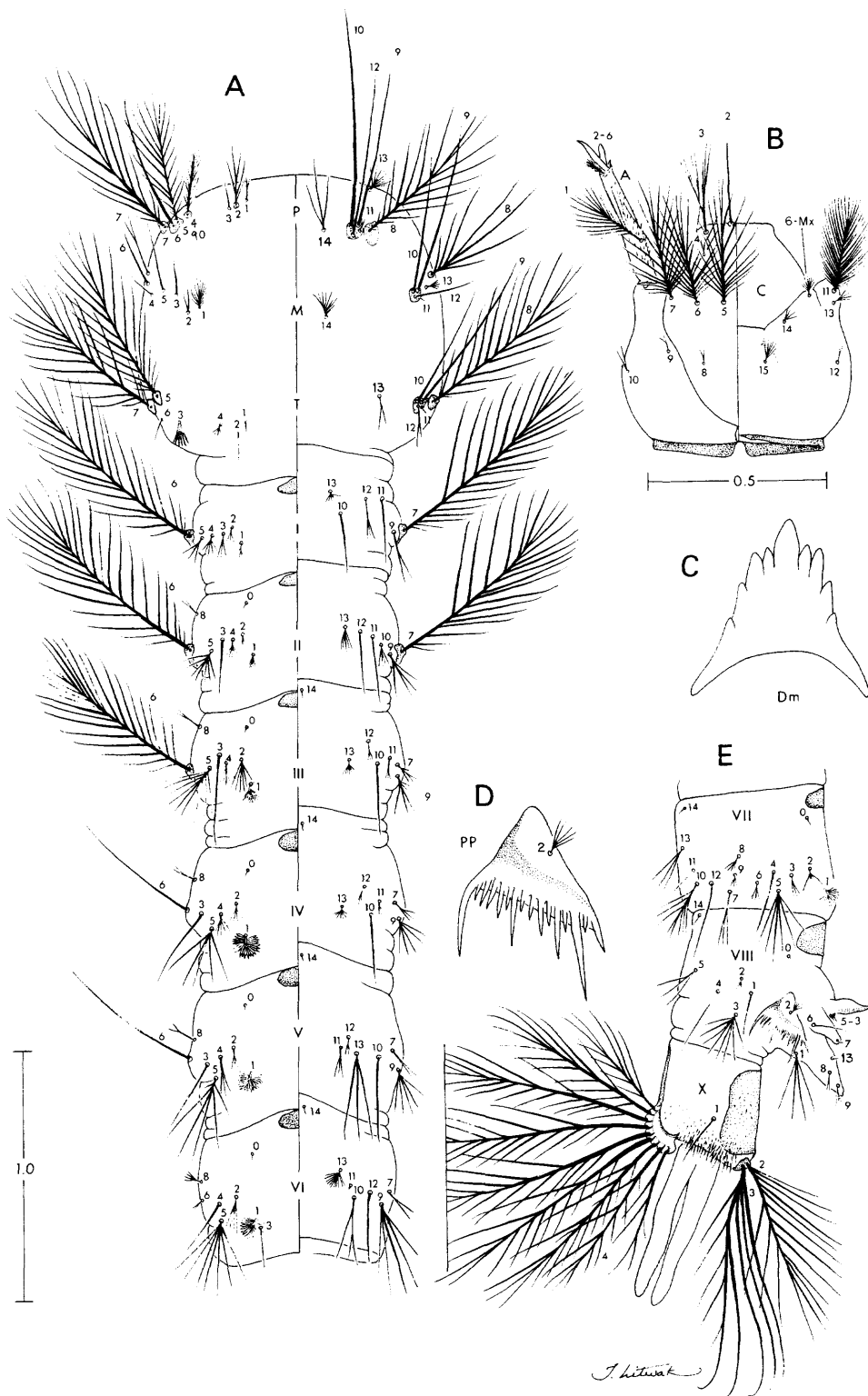


Fig. 3. *An. forattinii* n. sp. larva. (A) Thorax and abdominal segments I-VI, left side dorsal, right side ventral. (B) Head, left side dorsal, right side ventral. (C) Dorsomentum. (D) Pecten and pecten plate. (E) Abdominal segments VII-X side view. Scale in millimeters.

Table 3. Number of branches for setae of the larva of *An. forattinii*: range, mode ( ) based on counts made on 23-30 setae, except for seta 14-C, 9 counts and 1-III, 11 counts

Seta no.	Head		Thorax		Abdominal segments									
	C	P	M	T	I	II	III	IV	V	VI	VII	VIII	X	
0	-	1	-	-	-	1	1	1	1	1	1, 2 (1)	1	-	
1	1	1-5 (3)	13-21 (16)	1, 2 (1)	n.c.	n.c.	8-22 (17)	8-25 (18)	12-28 (18)	10-24 (21)	11-19 (14)	1	-	
2	2-7 (5)	3-8 (5)	1-4 (3)	1, 2 (1)	2-6 (3)	5-9 (6)	5-9 (6)	2-6 (3)	3-5 (3)	3-6 (4)	3-8 (5)	4-8 (5)	12-20 (15)	
3	5-10 (8)	1	1	n.c.	1-3 (2)	1	1	1, 2 (1)	1	1	1-5 (3)	1	7-11 (8)	
4	1-4 (2)	14-24 (20)	1, 2 (1)	3-6 (4)	5-11 (7)	4-9 (6)	4-8 (5)	3-7 (5)	2-4 (3)	1	1	1	8, 9 (9) <sup>a</sup>	
5	14-26 (18)	21-32 (24)	1	22-29 (25)	1-3 (2)	5-9 (6)	6-13 (8)	4-7 (5)	4-8 (5)	5-9 (7)	5-9 (6)	2-5 (3)	-	
6	14-24 (17)	1	1	1, 2 (2)	23-31 (26)	22-31 (27)	20-28 (23)	1	1	2-6 (4)	3-6 (3)	1	-	
7	15-30 (19)	12-20 (15)	1-3 (2)	16-22 (19)	17-23 (20)	17-25 (23)	1-3 (2)	2-7 (2)	2, 3 (2)	1-3 (2)	2-4 (3)	2-5 (4)	3, 4 (3)	
8	2-5 (3)	13-20 (17)	6-10 (8)	18-25 (22)	-	1-3 (2)	1-3 (1)	1-3 (1)	1-4 (2)	2-5 (4)	3-7 (5)	6-5	1	
9	1-4 (3)	1	1	1	2-4 (3)	3-7 (5)	4-9 (5)	3-6 (5)	4-7 (5)	4-8 (6)	1-4 (3)	7-5	1, 2 (1)	
10	2, 3 (2)	1	1	1	1, 2 (1)	2-4 (3)	1	1	1	2-6 (3)	5-8 (6)	8-5	1-3 (2)	
11	>40	1, 2 (1)	1, 2 (1)	1	1, 2 (1)	1	1-3 (2)	1-5 (3)	1-4 (2)	1, 2 (1)	1	9-5	2-5 (3)	
12	2, 3 (2)	1	1	2, 3 (2)	2, 3 (2)	1	1-3 (2)	1-3 (2)	2-4 (2)	1	1	-	-	
13	2-7 (4)	5-12 (8)	5-11 (6)	2	5-9 (6)	4-11 (6)	5-9 (7)	5-10 (6)	2-4 (3)	6-11 (9)	2-5 (3)	-	-	
14	4-8 (5)	2-4 (3)	8-12 (10)	-	-	-	1, 2 (1)	-	1, 2 (1)	1, 2 (1)	1, 2 (1)	-	-	
15	5-9 (5)	-	-	-	-	-	-	-	-	-	-	1, 2 (1)	-	

<sup>a</sup> Number of pairs.

♂G, -2 ♀ PeLe, -3 ♂ PeLe ♂G, -4 ♀, -5 ♂ PeLe, -6 ♂ PeLe, -7 ♂ PeLe, -8 ♂ PeLe, -9 ♀, -10 ♂ PeLe, -11 ♂ PeLe, -12 ♀ PeLe, -13 ♂ PeLe, -14 ♀ PeLe, -15 ♂ PeLe, -16 ♀ PeLe, -19 PeLe; 23-VII-1991, BR 427(1)-1 PeLe, -2 ♂ PeLe ♂G, -3 ♂ PeLe ♂G, -4 ♂ PeLe, -5 ♂, -6 ♂ PeLe, -7 ♀ PeLe, -8 ♂ PeLe, -9 ♂ PeLe, -10 ♂, -11 ♂ PeLe, -12 ♀ PeLe, -13 ♀ PeLe, -14 ♂ PeLe, -15 ♀ PeLe, -16 ♀ PeLe. Paratypes deposited in the National Museum of Natural History, Smithsonian Institution, Washington DC with examples deposited in: Coleção Entomológica de Referência, Faculdade de Saúde Pública, Universidade de São Paulo, Brazil; Fundação Instituto Oswaldo Cruz, Departamento de Entomologia, Rio de Janeiro, Brazil; Instituto Nacional de Pesquisas de Amazonia, Manaus, Brazil and; The Natural History Museum, London, England.

**Other Material Examined.** A total of 99 specimens in the National Museum of Natural History, Smithsonian Institution, Washington DC, consisting of 7 females, 28 males, 21 pupal exuviae, 2 pupae, 16 larval exuviae, 3 larvae, and 25 male genitalia. BRAZIL. Pará, Belém, IPEAN, Reserva de Aura, 11-VI-1970, Toda and Aitken colls., BRB 15 ♂ ♂G; same data, 20-VIII-1970, BRB 32 ♂ ♂G. Amazonas, Floresta, 4-VI-1979, T. and M. Faran, J. Bento, N. Fé, D. Roberts colls., BRZ 16-1 liter; BRZ 16-65 ♂ ♂G; BRZ 16-68 ♂ PeLe ♂G; BRZ 16-69 ♂ PeLe ♂G; BRZ 19-10 ♀ PeLe; BRZ 19-100 ♀ Pe; BRZ 19-108 ♂ Pe ♂G; BRZ 19-120 ♂ Pe ♂G; BRZ 27-1 P Le; BRZ 27-1 liter; BRZ 27-2 liter; BRZ 28-10 ♂ PeLe ♂G; BRZ 28-101 ♂ Pe ♂G; BRZ 28-11 ♂ PeLe ♂G; BRZ 28-12 ♂ PeLe ♂G; BRZ 28-13 ♀ PeLe; BRZ 28-14 ♂ PeLe ♂G; BRZ 28-15 ♀ PeLe; BRZ 28-16 ♂ PeLe ♂G; BRZ 28-18 ♂ PeLe; BRZ 28-20 ♀ PeLe; BRZ 28-21 P Le. COLOMBIA. Meta, "Tanané," 8-VII-1965, Osorno-Mesa and team colls., ♂ PeLe ♂G. Vaupes, Miraflores, 2-VII-1975, Kitzmiller coll., COZ 62 ♂ genitalia prep. 96/25; COZ 62, ♂ genitalia prep. 96/26. FRENCH GUIANA. Guyane, Forêt de Cogneau, 7-V-1968, J. Clastrier coll., FGC 351-1 ♂ ♂G; FGC 354-1 ♂ ♂G; FGC 352-7 ♂ ♂G; FGC 354-11 ♂ ♂G; same data, 29-IV-1968, FGC 3412-126 ♂ ♂G; FGC 3412-14 ♂ ♂G; same data Forêt de Cabassou, 29-VIII-1968, FGC 456-8 ♂ ♂G; FGC 458-2 ♂ ♂G. PERU. Loreto, Iquitos area, 14-24-IX-1996, PE 49(2) -100 ♀ Pe, -101 ♀ Pe; -102 ♂ Pe; PE 49(5) -1 ♂ PeLe. SURINAM. Moengo, 1945, ♂ ♂G.

**Distribution.** *An. forattinii* is known from Amazonian Brazil, Peru and Colombia, and French Guiana.

**Medical Importance.** Not known, but Klein et al. (1991a, b) found *An. mediopunctatus* s.l. to be as susceptible, or nearly as susceptible to *Plasmodium vivax* and *P. falciparum* as *An. (Nyssorhynchus) darlingi* Root. Their observations probably refer to *An. forattinii* because the other species, *An. costai*, formerly identified as *An. mediopunctatus*, was relatively rare in collections at their study site.

**Biology.** Little is known about the biology of *An. forattinii*. Larvae were collected from drying pools in stream beds and ground pools, and adults were collected at human bait. *An. mediopunctatus* s.l. larvae and adults are associated with heavily shaded forest

Table 4. Character and structure comparison for differentiating *An. forattinii*, *An. costai*, and *An. mediopunctatus*

Stage	Structure/character	<i>An. forattinii</i>	<i>An. costai</i>	<i>An. mediopunctatus</i>
Female	Cercus	Elliptical	As <i>An. forattinii</i>	Triangular
Male	9th tergal lobes	Nearly of equal width, parallel, close together medially, interlobal area small	As <i>An. forattinii</i>	Wide at base, tapers toward apex, arched outward, interlobal area wider
	Ventral lobe of claspette	With strong sinuous hook-like seta at apex, sparse small spicules scattered along dorsomesal surface, and a short apicodorsal projection bearing finger-like projections	As <i>An. forattinii</i>	With: strong sinuous seta at apex, numerous strong spicules along dorsomesal surface, without an apicodorsal projection
	Shape of ventral lobe of claspette	Elongate, somewhat triangular, curved dorsally at apex in lateral view	As <i>An. forattinii</i>	Nearly of equal width throughout, rounded at apex in lateral view
	Dorsal lobe of claspette	3 apically modified setae, one with a markedly expanded hooklike beak	As <i>An. forattinii</i>	2 apically rounded setae and 1 apically expanded seta bearing a small hook-like projection
	Shape of dorsal lobe of claspette	Somewhat triangular	Ovoid, nearly circular	Very reduced
	Area between ventral and dorsal lobes of claspette	Lobes well separated, area between lobes V-shaped	Lobes well separated, area between lobes U-shaped	Lobes poorly separated
Pupa	Lateral projections on wing case	2 well-developed	2 moderately developed	Absent
	Apical width segment VIII/apical width segment VII	1.09–1.2 (mean = 1.14)	0.97–1.03 (mean = 1.0)	0.92–1.03 (mean = 0.98)
	Paddle shape	Rounded	Ovoid	Ovoid
	Paddle length/width	1.01–1.16 (mean = 1.09)	1.24–1.42 (mean = 1.3)	1.36–1.47 (mean = 1.41)
	Posterior margins of terga II–VII	With distinct denticles	With less distinct denticles	Denticles sparse or indistinct
Larva	Antenna length/width	5.74–6.42 (mean = 6.02)	4.68–5.68 (mean = 5.17)	6.11–7.04 (mean = 6.46)
	Clypeal index	2.5–3.67 (mean = 3.07)	2.4–3.59 (mean = 2.93)	3.17–4.44 (mean = 3.79)
	Seta 1–II	Poorly developed	Somewhat developed	Somewhat developed

swamps. The larvae are difficult to raise in the laboratory, but were found to survive better if  $\approx 0.2$  g of NaCl/liter distilled water is used for rearing.

**Etymology.** This species is named for Oswaldo Paulo Forattini, collaborator and highly respected medical entomologist, for his outstanding contributions to the advancement of medical entomology.

### Discussion

We found no characters in the adult female to separate *An. forattinii*, *An. costai*, and *An. mediopunctatus*. Keys for the identification of adult female *An. mediopunctatus* s.l. usually use the following characters: lateral abdominal scale tufts, speckled femora, hindtarsomeres with broad white rings, hindtarsomere 5 all white, basal wing scales very broad, upper mesepimeron with a patch of scales and sternum I with scattered white scales (Russell et al. 1943, Deane et al. 1946, Lane 1953, Vargas 1959, Forattini 1962, Gorham

et al. 1967). Also, these 3 species share similar modifications of the male genitalia which include much elongated 9th tergal lobes and widely separated parabasal setae. However, they can easily be separated by features of the male genitalia, female genitalia, larva, and pupa (Table 4). There are, in addition, numerous, sometimes overlapping, differences in larval and pupal setal counts which are effective in combination for their identification (Table 5).

Pupal seta 1–XI is usually present in the above 3 species. This seta is found sporadically in several other mosquito groups (reviewed by Harrison and Peyton 1984). In Series Arribalzagia it was noted in *An. (Anopheles) vestitipennis* Dyar & Knab by Belkin et al. (1970). Harrison and Peyton (1984) report and illustrate it in *An. forattinii* (as *mediopunctatus*) based on specimens listed here from Brazil, Amazonas, Floresta. They also mention this seta in *An. (Anopheles.) costai* [as an undetermined *An. (Ano.)*] from Colombia, Restrepo, Balconcito and Brazil, Pará, Marabá (Sallum et al. 1999).

Table 5. Pupal and larval setal branch counts for distinguishing *An. forattinii*, *An. costai*, and *An. mediopunctatus*

Stage	Seta	<i>An. forattinii</i>	<i>An. costai</i>	<i>An. mediopunctatus</i>
Pupa	9-I	1-3 (2)	2-5 (3)	1, 2 (1)
	0-II	1-4 (2)	2-5 (3)	1, 2 (1)
	1-II	2-11 (3)	6-14 (10)	1-5 (3)
	3-II	2-6 (3)	4-8 (6)	1-3 (2)
	2-VI	2-9 (6)	7-14 (12)	5-10 (6)
	1-P	1-5 (3)	4-9 (7)	1-5 (4)
	2-P	1-3 (1)	2-5 (3)	1
	3-C	5-10 (8)	14-29 (23)	6-19 (12)
	4-C	1-4 (2)	2-7 (4)	1-3 (1)
	6-C	14-24 (17)	17-23 (18)	23-31 (25)
Larva	7-C	15-30 (19)	18-23 (18)	23-33 (27)
	12-C	2, 3 (2)	4-7 (4)	4-8 (7)
	14-C	4-8 (5)	1	1-3 (2)
	2-P	1-5 (3)	3-9 (6)	8-15 (10)
	7-P	12-20 (15)	16-30 (21)	26-37 (30)
	6-M	1	1	1-5 (3)
	7-M	1-3 (2)	2-5 (3)	4-9 (6)
	12-M	1	1	1-3 (2)
	11-II	1	1	2-5 (4)
	12-II	1	1	2-4 (3)
	10-III	1	1	1-5 (4)
	10-IV	1	1	2-6 (4)
	10-V	1	1	3-6 (4)
	12-VI	1	1	2-4 (3)
	12-VII	1	1	2-5 (3)
	4-VIII	1	1	2-4 (3)
	5-VIII	2-5 (3)	6-9 (7)	3-5 (3)

### Acknowledgments

We thank J. B. Lima for providing the majority of specimens for this description, B. A. Harrison for offering advice at the outset of this study and for his review of the manuscript, T. A. Klein and the United States Army Medical Research Unit-Brazil for support of collection and rearing of specimens, E. L. Peyton and R. F. Darsie for review of the manuscript, and T. R. Litwak for the illustrations. This study was partially supported by Grants 95/0381-7 and 97/8792-9 from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP), São Paulo, Brasil.

### References Cited

- Belkin, J. N., S. J. Heinemann, and W. A. Page. 1970. Mosquito Studies (Diptera, Culicidae). XXI. The Culicidae of Jamaica. Contrib. Am. Entomol. Inst. 6: 1-458.
- Deane, L. M., O. R. Causey, and M. P. Deane. 1946. Studies on Brazilian anophelines from the northeast and Amazon regions. I. An illustrated key by adult female characteristics for the identification of thirty-five species of Anophelini, with notes on the malaria vectors (Diptera, Culicidae). Am. J. Hyg. Monogr. Ser. 18: 1-20.
1948. Notas sobre a distribuição e a biologia dos anofelinos das regiões nordestinas e amazonica do Brasil. Rev. Serv. Esp. 1: 827-965.
- Forattini, O. P. 1962. Entomologia médica. vol. I. Parte Geral, Diptera, Anophelini. Faculdade de Higiene e Saúde Pública, Universidade de São Paulo, São Paulo, Brasil.
- Gorham, J. R., C. J. Stojanovich, and H. G. Scott. 1967. Illustrated key to the anopheline mosquitoes of eastern South America. National Communicable Disease Center, Atlanta, GA.
- Harbach, R. E., and K. L. Knight. 1980. Taxonomists' glossary of mosquito anatomy. Plexus, Marlton, NJ.
1982. Corrections and additions to taxonomists' glossary of mosquito anatomy. Mosq. Syst. 13: 201-217.
- Harrison, B. A., and E. L. Peyton. 1984. The value of the pupal stage to anopheline taxonomy, with notes on anomalous setae (Diptera: Culicidae). Mosq. Syst. 16: 201-210.
- Klein, T. A., J.B.P. Lima, M. S. Tada, and R. Miller. 1991a. Comparative susceptibility of anopheline mosquitoes in Rondonia, Brazil to infection by *Plasmodium vivax*. Am. J. Trop. Med. Hyg. 44: 463-470.
- Klein, T. A., J.B.P. Lima, and M. S. Tada. 1991b. Comparative susceptibility of anopheline mosquitoes to *Plasmodium falciparum* in Rondonia, Brazil. Am. J. Trop. Med. Hyg. 44: 598-603.
- Lane, J. 1953. Neotropical Culicidae. Editora da Universidade de São Paulo, São Paulo, Brasil.
- Lourenço-de-Oliveira, R., A. E. Guimarães, A. Monique, T. F. Silva, M. G. Castro, M. A. Motta, and L. M. Deane. 1989. Anopheline species, some of their habitats and relation to malaria in endemic areas of Rondonia State, Amazonas region of Brazil. Mem. Inst. Oswaldo Cruz Rio J. 84: 501-514.
- Reid, J. A., and K. L. Knight. 1961. Classification within the subgenus *Anopheles* (Diptera, Culicidae). Ann. Trop. Med. Parasitol. 55: 474-488.
- Russell, P. F., L. E. Rozeboom, and A. Stone. 1943. Keys to the anopheline mosquitoes of the world with notes on their identification, distribution, biology, and relation to malaria. American Entomological Society and Academy of Natural Science, Philadelphia, PA.
- Sallum, M.A.M., R. C. Wilkerson, and O. P. Forattini. 1999. Taxonomic study of species formerly identified as *Anopheles mediopunctatus* and resurrection of *An. costai* (Diptera: Culicidae). J. Med. Entomol. 36: 282-300.
- Tadei, W. P., B. M. Mascarenhas, and M. G. Podestá. 1983. Biologia de anofelinos amazônicos. VIII. Conhecimentos sobre a distribuição de espécies de *Anopheles* na região de Tucuruí-Marabá (Pará). Acta Amazonica 13: 103-140.
- Tadei, W. P., J.M.M. Santos, W.L.S. Costa, and V. M. Scarpas. 1988. Biologia de anofelinos amazônicos. XII. Ocorrência de espécies de *Anopheles*, dinâmica da transmissão e controle da malária na zona urbana de Ariquemes (Rondonia). Rev. Inst. Med. Trop. São Paulo 30: 221-251.
- Vargas, L. 1959. Lista de *Anopheles* de las Americas y su identificación por caracteres masculinos (Diptera: Culicidae). Rev. Inst. Salubr. Enferm. Trop. 19: 367-386.
- Wilkerson, R. C., and E. L. Peyton. 1990. Standardized nomenclature for the costal wing spots of the genus *Anopheles* and other spotted-wing mosquitoes (Diptera: Culicidae). J. Med. Entomol. 27: 207-224.

Received for publication 7 May 1998; accepted 13 October 1998.